

Final Report

WATER CONSERVATION STUDY

**BADGER ARMY AMMUNITION PLANT
BARABOO, WISCONSIN**

Prepared for

Department of the Army
U.S. Army Engineer District
Omaha, Nebraska

Under

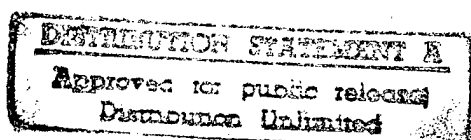
U.S. Army District, Mobile
IDIQ Contract for A-E Services
Contract No. DACA01-94-D-0033
Delivery Order No. 0004
EMC No. 1406-004

May 1995

By

E M C Engineers, Inc.
2750 S. Wadsworth, Suite C-200
Denver, Colorado 80227
303 / 988-2951

19971016 150



DTIC QUALITY INSPECTED 2

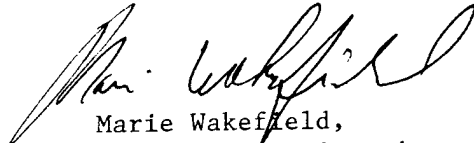


DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited.
Distribution A. Approved for public release.


Marie Wakefield,
Librarian Engineering

This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of EMC Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, EMC Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

TABLE OF CONTENTS

<i>List of Tables</i>	<i>iv</i>
<i>List of Figures</i>	<i>iv</i>
<i>List of Abbreviations</i>	<i>v</i>
EXECUTIVE SUMMARY	1
1. INTRODUCTION	1-1
1.1 AUTHORITY FOR STUDY	1-1
1.2 PURPOSE OF STUDY	1-1
1.3 BACKGROUND	1-1
1.4 SCOPE OF WORK	1-3
1.5 APPROACH	1-3
2. DESCRIPTION OF EXISTING CONDITIONS	2-1
2.1 GENERAL	2-1
2.1.1 <i>History of Process Water System</i>	2-1
2.1.2 <i>Description of Buildings Served</i>	2-1
2.1.3 <i>Description of Process Water Piping System</i>	2-2
2.1.4 <i>Description of Wells</i>	2-2
2.1.5 <i>Pump and Treat (IRM) Facility</i>	2-3
2.2 LEAK DETECTION SURVEY	2-3
2.2.1 <i>Method of Analysis</i>	2-4
2.2.2 <i>Summary of Results</i>	2-4
2.3 CONDITION OF PROCESS WATER PIPING SYSTEM	2-5
2.3.1 <i>General</i>	2-5
2.3.2 <i>Piping Designated by BAAP</i>	2-5
2.3.3 <i>Leaks Occurring in "Caretaker" Areas</i>	2-6
3. WATER SYSTEM ENERGY AUDIT	3-1
3.1 ENERGY AND MAINTENANCE COSTS	3-1
3.1.1 <i>Energy Costs</i>	3-2
3.1.2 <i>Maintenance Costs</i>	3-3
3.1.3 <i>Potential Future Costs</i>	3-4
3.2 LIFE CYCLE COST ANALYSIS METHODOLOGY	3-5
3.3 ENERGY CONSERVATION OPPORTUNITIES	3-5
3.3.1 <i>ECO #1: Implement Leak Detection Program</i>	3-5
3.3.2 <i>ECO #2: Reline Designated Sections of Piping in Poor Condition</i>	3-8
3.3.3 <i>ECO #3: Isolate Piping in "Caretaker" Areas</i>	3-9
4. SUMMARY AND RECOMMENDATIONS	4-1
4.1 SUMMARY OF THE BAAP PROCESS WATER SYSTEM	4-1
4.2 SUMMARY OF ENERGY AUDIT	4-2
4.3 RECOMMENDATIONS	4-2
5. REFERENCES	5-1

APPENDICES

- A Scope of Work and Confirmation Notices
- B Field Notes
- C Leak Detection Survey
- D Energy Audit Calculations
- E Programming Documentation

LIST OF TABLES

Table 1. Summary of ECOs	3
Table 2-1. Process Water Well Nameplate Data	2-2
Table 2-2. Water Usage Rates (Gal/Yr)	2-3
Table 2-3. BAAP-Designated Piping in Poor Condition	2-5
Table 3-1. Process Water System Pump Characteristics	3-3
Table 3-2. Total Well Water Usage (1992-September 1994)	3-3
Table 3-3. Water Audit Results	3-6
Table 3-4. ECO #1 Economic Analysis	3-7
Table 3-5. ECO #2 Economic Analysis	3-9
Table 3-6. ECO #3 Economic Analysis	3-11
Table 3-7. Water Audit Results	3-12
Table 3-8. ECO #4 Economic Analysis	3-13
Table 4-1. Summary of ECOs	4-2

LIST OF FIGURES

Figure 2-1. Process Water Piping for BAAP Northwest	2-7
Figure 2-2. Process Water Piping for BAAP West	2-8
Figure 2-3. Process Water Piping for BAAP Rocket Area East	2-9

LIST OF ABBREVIATIONS

A	-	ampere
BAAP	-	Badger Army Ammunition Plant
COE	-	Corps of Engineers
CY	-	cubic yards
ECIP	-	Energy Conservation Investment Program
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	Fahrenheit
ft	-	foot, feet
ft ²	-	square feet
gal	-	gallons
gpd	-	gallons per day
gpm	-	gallons per minute
hp	-	horsepower
hr	-	hour
in	-	inch
IRM	-	Pump and Treat Facility
kgal	-	kilo-gallon, one thousand gallons
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours
LCCA	-	Life Cycle Cost Analysis
LF	-	linear foot (feet)
MES	-	M.E. Simpson Co., Inc.
mi	-	mile(s)
O&M	-	operation and maintenance manual
rpm	-	revolutions per minute
SIOH	-	supervision, inspection and overhead
SIR	-	Savings-to-Investment Ratio
SOW	-	scope of work
SPB	-	simple payback

temp	-	temperature
UPW	-	Uniform Present Worth factor
yr	-	year(s)

EXECUTIVE SUMMARY

INTRODUCTION

Authorization for Study

This study was conducted and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 0004. The contract was issued by the Department of the Army, Mobile District, Corps of Engineers, to E M C Engineers, Inc. (EMC).

Purpose of Study

The purpose of this water conservation study is to identify projects which will result in energy maintenance and cost savings in the process water distribution system at Badger Army Ammunition Plant (BAAP) in Baraboo, Wisconsin.

Method of Analysis

Specific work required includes:

1. Perform a limited site survey of the process water system to collect data required to evaluate specific energy conservation opportunities (ECOs).
2. Conduct a thorough survey of the process water system using state-of-the-art underground leak detection equipment on all piping 6 inches and larger.
3. Develop a process water map which shows the location and estimated quantity of leaks identified during the leak detection survey.
4. Evaluate specific ECOs to determine energy savings potential and economic feasibility.
5. Provide project documentation for recommended ECOs.
6. Prepare a report to document work performed, and to describe the results and recommendations of a site and energy audit and the leak detection study.

This study does not include an audit of the potable or raw water system at BAAP.

LEAK DETECTION SURVEY

A leak detection survey was performed on all process water piping with a diameter of 6 inches or greater. The leak detection analysis was performed using a combination of listening devices and preamplified-transducer systems to identify the majority of leak locations. When the location of the leak could not be readily identified using these

methods, a leak correlator was used. The leak correlator determines leak location based on the time it takes for sound to travel from the leak to a waterline connection point.

Sixty-four leaks were identified by the survey on the water mains within the project scope area. The estimated leakage of 194,500 gallons per day (gpd) was separated into the following types of leaks:

- Fifty fire hydrant leaks at 37,500 gpd
- Five main line leaks at 143,000 gpd.
- Eight valve leaks at 11,000 gpd.
- One service line leak at 3,000 gpd.

ENERGY CONSERVATION OPPORTUNITIES

The majority of water usage in the process water system is due to leakage. ECOs were evaluated that would serve to reduce leakage, thereby reducing pumping, chemical treatment, and maintenance costs.

Description of ECOs

Four ECOs were identified to reduce leakage in the process water system. These four ECOs are:

- ECO #1. Implement a water audit and leak detection program.
- ECO #2. Clean and reline with cement four lines designated by BAAP personnel as having historically high occurrences of leakage.
- ECO #3. Isolate piping that is located in areas classified as "Caretaker" areas. "Caretaker" areas consist of a number of buildings identified by BAAP personnel which do not require maintenance. Fire protection would only be provided along the perimeter of "Caretaker" to inhibit the spread of fire to those areas not designated "Caretaker".
- ECO #4. Implement a water audit and leak detection program, taking into account the effects of implementing ECO #2 and #3 on the process water system.

Economic Analysis

The economic analysis of the ECOs is summarized in Table 1.

Table 1. Summary of ECOs

ECO No.	Description	Investment Cost	Annual Water Savings*	Total Disc. Savings	SIR	Payback (yrs)
1	Implement Leak Detection	\$20,160	116.73	\$524,574	30.34	0.49
2	Reline Design. Main Lines	724,676	54,636	1,278,139	1.76	8.45
3	Isolate Caretaker Areas	71,403	18.73	438,211	6.14	2.43
3A	Isolate Area #8	13,654	2.75	64,374	4.71	3.16
3B	Isolate Area #1	8,324	1.00	23,411	2.81	5.30
3C	Isolate Area #12	5,351	3.13	73,152	13.67	1.09
3D	Isolate Area #13	13,676	1.20	28,143	2.06	7.25
3E	Isolate Area #9	13,589	1.46	34,061	2.51	5.95
3F	Isolate Area #18	16,807	9.20	215,094	12.80	1.17
4	Leak Detection After #2,#3	17,640	61.71	323,356	18.33	0.82

*Annual Water Savings are in units of millions of gallons saved per year

ECO Nos. 1, 2, 3 and 4 all display favorable economic payback. That is, they all have SIRs greater than 1.25 and simple paybacks of 10 years or less. Based on the qualifications listed by the Scope of Work, all of the ECOs qualify for government energy conservation funding programs.

RECOMMENDATIONS

The following ECOs are recommended for implementation:

- **ECO #1. Implement a leak detection program**, including a water audit, every two years as recommended by AWWA Manual 36. Continue with BAAP's policy to immediately excavate and repair all leaks discovered by the leak detection surveys.
- **ECO #2. Clean and reline with cement the following main lines:**
 1. 24-inch diameter pipe that runs along coordinate East 2,023. This section starts at Valve 368 to the north and ends at Valve F-9 to the south. The pipe has a total length of 2,644 feet and supplies 10 branches.
 2. 24-inch diameter pipe that runs along coordinate East 3,013. This section starts at Valve 281 to the north, and ends at Valve F-11 to the south. This pipe has a total length of 2,244 feet and supplies 12 branches.
 3. 14-inch diameter pipe that runs along coordinate East 4,885. This section starts at Valve 268 to the north and ends at Valve 341 to the south. The pipe has a total length of 2,870 feet and supplies 38 service branches.

4. 14-inch diameter pipe that runs along coordinate East 4,215. This section starts at Valve 204 to the north and ends at Valve 242 to the south. The pipe has a total length of 2,440 feet and supplies 22 branches.

These pipe lengths were chosen based upon evaluation of leakage frequency by BAAP personnel. The grand total of pipe to be cleaned and relined is 4,890 feet of 24-inch diameter steel pipe, and 5,310 feet of 14-inch diameter steel pipe.

- **ECO #3. Isolate process water piping** in "Caretaker" Area No. 1, 8, 9, 12, 13, and 18. If this ECO is implemented, special care must be taken that the buildings in these areas remain in "Caretaker" status. If, in the future, buildings are taken off "Caretaker" status, fire protection must be restored to those buildings.
- **ECO #4. Implement a leak detection program**, including a water audit, as recommended in ECO #1. However, this ECO should only be considered if ECO #2 and #3 are implemented first.

Note that the recommendations and programming documentation for ECO #1 and #4 are identical except that ECO #1 is based on current process water system conditions and EO #4 is based on the estimated condition of the process water system after ECO #2 and #3 are implemented. BAAP personnel should determine the appropriate time to submit either ECO #1 or ECO #4 for government funding.

Budger 100, 100

ECO#	Volume of gas/yr	Annual Cost
1	116.73	40.740
* 2	54,636	85.724
* 3	18.73	29.390
20	2.75	
21	1.00	
22	3.13	
23	1.20	
24	1.46	
25	9.20	
* 4	61.71	21.536
TOTALS for 2, 3, & 4	54,717	136,650



TRANSMITTAL

2750 South Wadsworth Blvd. Suite C-200
Denver, Colorado 80227-3400
303/988-2951 Fax: 303/985-2527

TO:

Commander
U.S. Army Engineer District, Mobile
ATTN: CESAM-EN-CC (T. Battaglia)
P.O. Box 2288
Mobile, AL 36628-001

FM: Michael Scholz

DT: 16 May 1995

PROJECT: Water /Energy Conservation Study-
BAAP

CONTRACT NO.: DACA-94-D-0033

EMC NO.: 1406-004

WE ARE SENDING YOU:

Qty	Date	Description
1		Final Report-Water Conservation Study-BAAP

THESE ARE TRANSMITTED:

☐ For approval ☐ For review and comment ☐ For your use ☐ Per your request ☐ Other (see below)

REMARKS:

Mr. Battaglia:
As per contract documents, this copy of the report is sent to you for review.
If you have any questions, please call me at 303-988-2951. Thank you.

Sincerely,

cc: S. Owens

Signed: